(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 739 130 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
18.11.2020 Bulletin 2020/47

(51) Int Cl.:
E02F 3/88 *(2006.01)* ***E02F 7/02*** *(2006.01)*
E02F 7/06 *(2006.01)*

(21) Application number: **20173185.8**

(22) Date of filing: **06.05.2020**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **06.05.2019 NL 2023075**

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(54) EXCAVATOR HAVING A SUCTION PUMP AND METHOD OF EXCAVATING MATERIAL WITH SUCH AN EXCAVATOR

(57) The present invention relates to an excavator (1), comprising:
- a driveable mobile carrier (4) that comprises a discharge (10);
- a suction pump (2) that is connected to a suction hose (3);
- a container (6) that is configured to:
- temporarily store excavation material (7); and
- simultaneously, without interruption of suction of excavation material (7) by the suction pump (2), receive excavation material (7) via an inlet (8) that is connected to the suction hose (3) and discharge excavation material (7) via an outlet (9) that is connectable to the discharge (10);

- a superstructure (11) that comprises the container (6) and that is rotatably connected to the mobile carrier (4) with a radial bearing (12); and
- an outlet guide (15) that is arranged between the outlet (9) and the discharge (10) and that passes through said radial bearing (12).

The invention further relates to a method of excavating material with such an excavator.

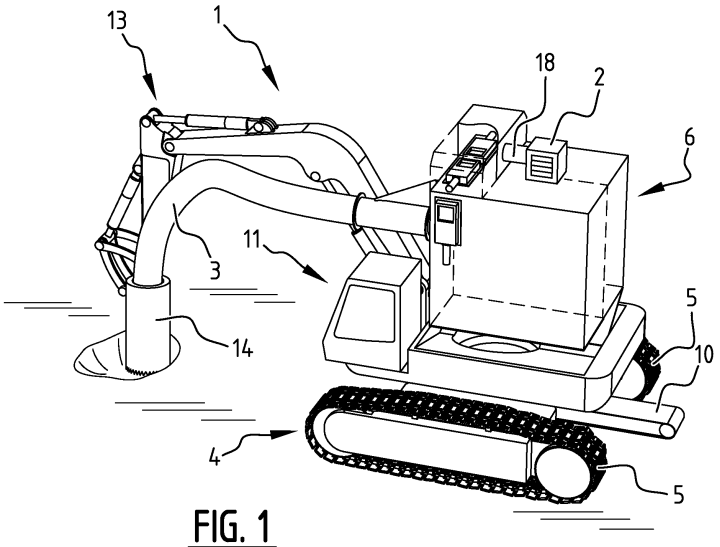

FIG. 1

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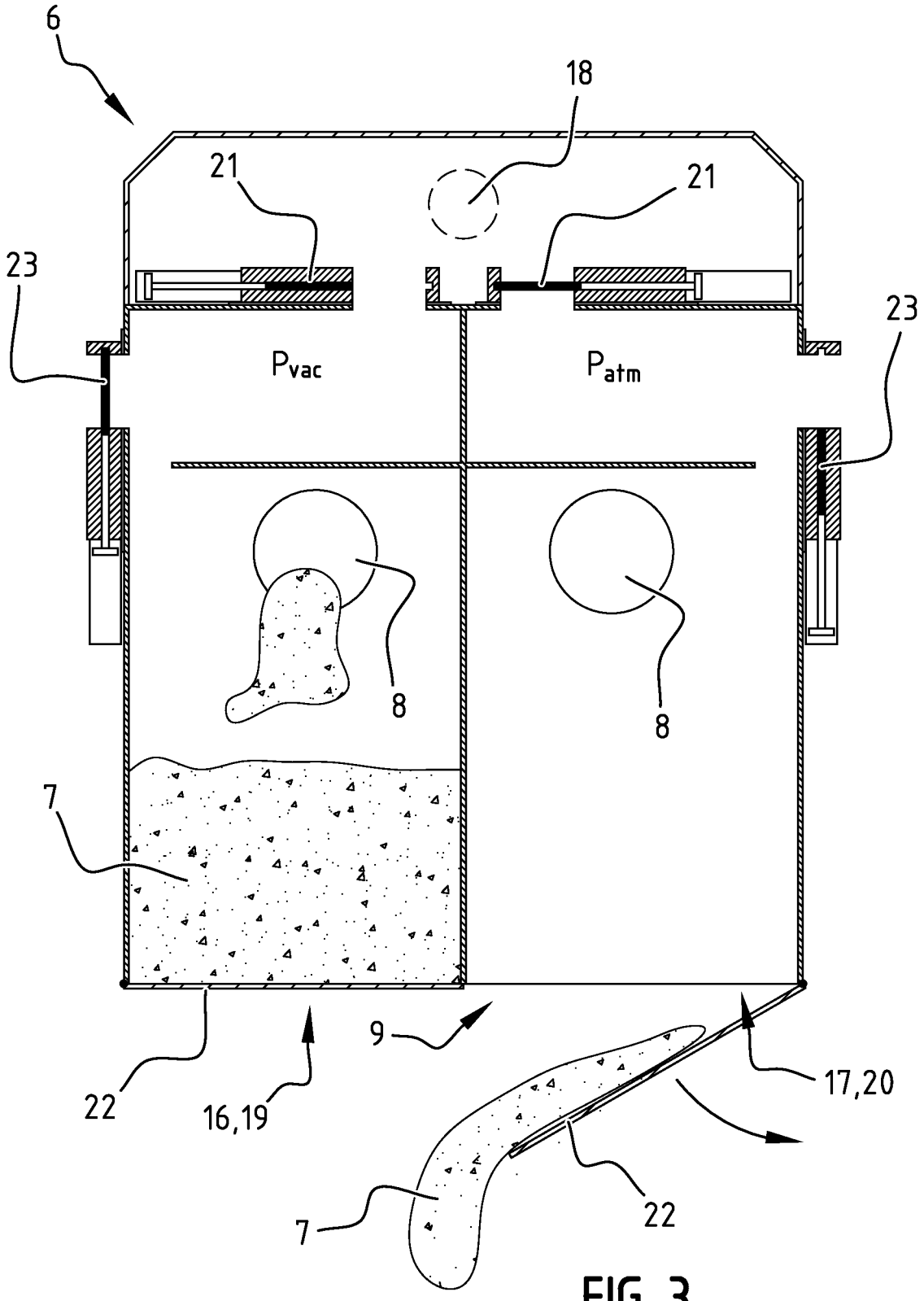

FIG. 3

Description

[0001] The present invention relates to an excavator, comprising a suction pump that is connected to a suction hose, and a container that is configured to temporarily store excavation material.

[0002] The invention is further related to a method of excavating material with an excavator having a suction pump, comprising the steps of:

- suctioning excavation material with the suction pump; and
- receiving and temporarily storing the suctioned excavation material in a container

[0003] Excavators that comprise a suction pump and that are configured to suction material provide an alternative to conventional digging in the ground that is less prone to cause damage to underground infrastructure, such as cables and conduits.

[0004] Prior art suction excavators are available as large excavator trucks having a large container for storing excavation material. However, over time even a large container needs to be emptied. This requires the excavator truck to drive away from the excavation site and thus results in an interruption of the work. A solution could be to exchange the excavator truck that needs to be emptied for another excavator truck having enough space left in the container thereof. This would require at least two dedicated excavator trucks, which is a luxury most contactors cannot afford.

[0005] Prior art suctions excavators are also available as compact units, which have the disadvantage that they may only receive a limited amount of exaction material in their container before the container needs to be emptied, again causing an interruption of the work.

[0006] United States patent US 5,425,188 is related to a suction excavator, and is considered the closest prior art. It discloses a suction excavator having a storage tank wherein suctioned material is received and separated from the suction air flow. A conveyor by which the suctioned material separated from the air flow can be removed continuously or at intervals from the storage tank may be provided on tank bottom. The suction excavator is again a large excavator truck, necessary for accommodating filter means comprising a coarse filter defined by a voluminous labyrinth or cascade-like flow channel, and a fine filter downstream thereof. Said fine filter is configured to retain those particles which, as a result of their relatively low mass, managed to follow the deflections in the labyrinth-like flow channel of the coarse filter. Such a large truck has a limited versatility and maneuverability. Relative to this document, at least the characterizing features of claim 1 are novel.

[0007] DE 299 23 449 U1, US 2010/095559 A1, JP S58 222225 A and US 3 206 048 A are acknowledged as further prior art.

[0008] An objective of the present invention is to provide an excavator and a method of excvating, that is improved relative to the prior art and wherein at least one of the above stated problems is obviated.

[0009] Said objective is achieved with the excavator according to claim 1 of the present invention, comprising:

- a driveable mobile carrier that comprises a discharge;
- a suction pump that is connected to a suction hose;
- a container that is configured to:
  - temporarily store excavation material; and
  - simultaneously, without interruption of a suction of excavation material by the suction pump, receive excavation material via an inlet that is connected to the suction hose and discharge excavation material via an outlet that is connectable to a discharge;
- a superstructure that comprises the container and that is rotatably connected to the mobile carrier with a radial bearing; and
- an outlet guide that is arranged between the outlet and the discharge and that passes through said radial bearing.

[0010] Due to the container being configured to simultaneously receive and discharge excavation material without interruption of a suction of excavation material by the suction pump, the container may at least be partly emptied while further excavation material is suctioned by the suction pump and received in the container. Thus, work may continue continuously, while offering optimized versatility and maneuverability due to the superstructure that comprises the container being rotatably connected to the mobile carrier with a radial bearing, and the outlet guide that is arranged between the outlet and the discharge and that passes through said radial bearing. After all, the superstructure may rotate relative to the mobile carrier during work, thereby allowing the superstructure to position the suction hose at a desired location without the need to displace or turn the mobile carrier itself. The outlet guide passing through the radial bearing even allows a discharge of excavation material while simultaneously suctioning or rotating the superstructure relative to the mobile carrier. The thereby obtained improved versatility and maneuverability relative to the prior art also enables the excavator according to the invention to be used for excavation work in limited spaces, such as in small gardens, driveways and footpaths between a sidewalk and a front door of a building.

[0011] According to the invention, said objective is furthermore achieved with the method of excavating material with an excavator having a suction pump, comprising the steps of:

- suctioning excavation material with the suction pump;

- receiving and temporarily storing the suctioned excavation material in a container; and
- at least partially emptying of the container by discharging excavation material out of the container while the simultaneous step of suctioning excavation material is uninterrupted.;
- using an excavator according to the invention for displacing excavation material via the outlet guide that is arranged between the outlet and the discharge and that passes through the radial bearing that rotatably connects the superstructure to the mobile carrier.

[0012] Preferred embodiments are the subject of the dependent claims.

[0013] The various aspects and features described and shown in the specification can be applied, individually, wherever possible. These individual aspects, and in particular the aspects and features described in the attached dependent claims, may be made subject of divisional patent applications.

[0014] In the following description preferred embodiments of the present invention are further elucidated with reference to the drawing, in which:

Figure 1 is a perspective view of an excavator according to a first embodiment of the invention;
Figure 2 is a detailed perspective cross-sectional view of the excavator of Figure 1;
Figure 3 is a schematic cross-sectional view of a container of the excavator of Figures 1 and 2; and
Figures 4A-4C show schematic cross-sectional views of successive steps of a container according to a second embodiment of the excavator.

[0015] The excavator 1 shown in Figure 1 comprises a suction pump 2 that is connected to a suction hose 3 and a container 6. The container 6 is configured to temporarily store excavation material 7 and, simultaneously, without interruption of a suction of excavation material 7 by the suction pump 2, receive excavation material 7 via an inlet 8 that is connected to the suction hose 3 and discharge excavation material 7 via an outlet 9 that is connectable to a discharge 10.

[0016] In Figure 1, the excavator 1 comprises a driveable mobile carrier 4, that comprises two independently driveable tracks 5. Alternatively, (not shown) wheels may be applied. A superstructure 11 is rotatably connected to the mobile carrier 4 with a radial bearing 12, such as a slewing ring bearing. The superstructure 11 comprises an articulated arm 13 that is configured to direct the suction hose 3, especially a nozzle 14 arranged at an end thereof.

[0017] The superstructure 11 comprises the container 6, and due to the radial bearing 12 an operator of the excavator is able to rotate the superstructure 11 relative to the mobile carrier 4.

[0018] The mobile carrier 4 may comprise the discharge 10. In order to allow rotation of the superstructure 11 relative to the mobile carrier 4 without interruption of the suctioning of excavation material by the suction pump 2, the excavator 1 further comprises an outlet guide 15 that is arranged between the outlet 9 and the discharge 10 and that passes through the radial bearing 12.

[0019] The discharge 10 may extend from the excavator 1 in a sideward direction, e.g. rearward in the embodiment shown in Figures 1 and 2. In this way, the excavation material 7 may be directed away from the excavator 1. It may be temporarily dumped adjacent / behind the excavator 1 if a trench is to be filled again after e.g. a cable or conduit has been repaired or arranged in the trench. Alternatively, the discharge 10 may lead to a conventional (not shown) dump truck, which most contractors can afford to have two readily available at a work site.

[0020] The excavator 1 comprises a receiving mode wherein the container 6 is configured to receive the excavation material 7 and a discharge mode wherein the container 6 is configured to discharge excavation material 7 to the discharge 10.

[0021] The container 6 comprises a receiving compartment 16 configured to receive and temporarily store the excavation material 7, and a discharge compartment 17 configured to discharge the excavation material 7 out of the container 6 without interruption of the suction of excavation material 7 by the suction pump 2.

[0022] The receiving compartment 16 is configured to operate in the receiving mode, and the discharge compartment 17 is configured to operate in the discharge mode.

[0023] In the receiving mode, the receiving compartment 16 is in fluid connection with the suction hose 3 via inlet 8 and with the suction pump 2 via conduit 18. Also in the receiving mode, the receiving compartment 16 is substantially hermetically sealed off from the environment.

[0024] In the discharge mode, the discharge compartment 17 is in fluid connection with the outlet 9 and the discharge 10, possibly via the outlet guide 15. Also in the discharge mode, the discharge compartment 17 is in fluid connection with the environment. In this way, ambient pressure allows the excavation material 7 to be discharged from the discharge compartment 17. If the outlet 9 is arranged at a lower side of the discharge compartment 17, discharge of the excavation material 7 may be based on gravity.

[0025] According to a first embodiment shown in detail in Figure 3, the container 6 comprises two container halves 19, 20 that are configured to oppositely alternate between the receiving mode and the discharge mode. As indicated in Figure 3, the left container half 19 is in the receiving mode (at a vacuum pressure P_{vac}) and thus functions as the receiving compartment 16. At the same time, the right container half 20 is in the discharge mode and thus functions as the discharge compartment 17. The pressure in the right container half 20 is an atmospheric pressure P_{atm}. However, the functionalities of the

left container half 19 and the right container half 20 oppositely alternate, meaning that in another (not shown) stage, the left container half 19 is being emptied and is thus in the discharge mode and functioning as the discharge compartment 17, while the right container half 20 is simultaneously functioning as a receiving compartment 16.

[0026] In order to be able to oppositely alternate the left container half 19 and the right container half 20 between the receiving mode and discharge mode and vice versa, a number of valves 21, 22, 23 are applied.

[0027] In the shown embodiment of Figure 3, each of the two container halves 19, 20 comprises an internal valve 21 that is configured to selectively connect or disconnect the respective container half 19, 20 to or from the suction pump 2. The suction pump 2 is in fluid connection with the container via conduit 18.

[0028] Moreover, each of the two container halves 19, 20 comprises an external valve 22 that is configured to selectively connect or disconnect the outlet 9 of the respective container half 19, 20 to or from the discharge 10. In Figures 3 and 4, the external valve 22 is illustrated as a bottom wall that may pivot to open the respective container half 19, 20.

[0029] Optionally, each of the two container halves 19, 20 may further comprise a further external valve 23 that is configured to selectively seal the respective container half 19, 20 off from the environment or connect the respective container half 19, 20 to the environment. This optional further external valve 23 helps to equalize the pressure of the respective container half 19, 20 with the ambient pressure, allowing the bottom wall that form the external valve 22 to open easily without having to counteract an under pressure inside the respective container half 19, 20.

[0030] The two container halves 19, 20 are sealed relative to each other.

[0031] According to a second embodiment shown in detail in Figures 4A-4C, the container 6 comprises the discharge compartment 17 arranged downstream of the receiving compartment 16. Similar reference numbers apply to the similar features for this second embodiment. A shutoff valve 24 is arranged between the discharge compartment 17 and the receiving compartment 16. If the discharge compartment 17 is filled with excavation material 7, the shutoff valve 24 may be closed to seal the receiving compartment 16 from the discharge compartment 17 (Figure 4B). Once the shutoff valve 24 is closed, the external valve 22 formed by the bottom wall may open to discharge the excavation material 7 from the discharge compartment 17. Simultaneously, the suction pump 2 may cause a vacuum in the receiving compartment 16 via conduit 18, allowing excavation material 7 to be sucked into the receiving compartment 16 via suction hose 3 and inlet 8.

[0032] If the receiving compartment 16 comprises funnel shaped guide surfaces 25, any excavation material 7 will be guided onto the shutoff valve 24 (Figure 4C). Once the external valve 22 is closed and the shutoff valve 24 is opened again, the excavation material 7 that has been received in the receiving compartment 16 during emptying of the discharge compartment 17 immediately falls into the discharge compartment 17.

[0033] Optionally, external valves 23 similar to the Figure 3 embodiment may be arranged in the discharge compartment 17.

[0034] The invention is further directed to a method of excavating material with an excavator 1 having a suction pump 2, comprising the steps of:

- suctioning excavation material 7 with the suction pump 2;
- receiving and temporarily storing the suctioned excavation material 7 in a container 6; and
- at least partially emptying of the container 6 by discharging excavation material 7 out of the container 6 while the simultaneous step of suctioning excavation material is uninterrupted. Preferably, an excavator 1 as described above is used for performing this method.

[0035] Although they show preferred embodiments of the invention, the above described embodiments are intended only to illustrate the invention and not to limit in any way the scope of the invention. Accordingly, it should be understood that where features mentioned in the appended claims are followed by reference signs, such signs are included solely for the purpose of enhancing the intelligibility of the claims and are in no way limiting on the scope of the claims. Furthermore, it is particularly noted that the skilled person can combine technical measures of the different embodiments. The scope of the invention is therefore defined solely by the following claims.

Claims

1. An excavator (1), comprising:

- a driveable mobile carrier (4) that comprises a discharge (10);
- a suction pump (2) that is connected to a suction hose (3);
- a container (6) that is configured to:
  - temporarily store excavation material (7); and
  - simultaneously, without interruption of suction of excavation material (7) by the suction pump (2), receive excavation material (7) via an inlet (8) that is connected to the suction hose (3) and discharge excavation material (7) via an outlet (9) that is connectable to the discharge (10),

characterized in that it further comprises:
- a superstructure (11) that comprises the container (6) and that is rotatably connected to the mobile carrier (4) with a radial bearing (12); and
- an outlet guide (15) that is arranged between the outlet (9) and the discharge (10) and that passes through said radial bearing (12).

2. Excavator according to claim 1, comprising:

- a receiving mode wherein the container (6) is configured to receive the excavation material (7); and
- a discharge mode wherein the container (6) is configured to discharge excavation material (7) to the discharge (10).

3. Excavator according to claim 1 or 2, wherein the container (6) comprises:

- a receiving compartment (16) configured to receive and temporarily store the excavation material (7); and
- a discharge compartment (17) configured to discharge the excavation material (7) out of the container (6) without interruption of the suction.

4. Excavator according to claims 2 and 3, wherein:

- the receiving compartment (16) is configured to operate in the receiving mode; and
- the discharge compartment (17) is configured to operate in the discharge mode.

5. Excavator according to claim 4, wherein, in the receiving mode, the receiving compartment (16) is at least one of:

- in fluid connection with the suction hose (3) and the suction pump (2); and
- substantially hermetically sealed off from the environment.

6. Excavator according to claim 4 or 5, wherein, in the discharge mode, the discharge compartment (17) is at least one of:

- in fluid connection with the outlet (9) and the discharge (10); and
- in fluid connection with the environment.

7. Excavator according to any of claims 2-6, wherein the container (6) comprises two container halves (19, 20) that are configured to oppositely alternate between the receiving mode and the discharge mode.

8. Excavator according to claim 7, wherein each of the two container halves (19, 20) comprises an internal valve (21) that is configured to selectively connect or disconnect the respective container half (19, 20) to or from the suction pump (2).

9. Excavator according to claim 7 or 8, wherein each of the two container halves (19, 20) comprises an external valve (22) that is configured to selectively connect or disconnect the outlet (9) of the respective container half (19, 20) to or from the discharge (10).

10. Excavator according to any of claims 7-9, wherein each of the two container halves (19, 20) comprises a further external valve (23) that is configured to selectively seal the respective container half (19, 20) off from the environment or connect the respective container half (19, 20) to the environment.

11. Excavator according to any of claims 7-10, wherein the two container halves (19, 20) are sealed relative to each other.

12. Excavator according to claim 2 and/or any of claims 3-6, wherein:

- the discharge compartment (17) is arranged downstream of the receiving compartment (16); and
- a shutoff valve (24) is arranged between the discharge compartment (17) and the receiving compartment (16).

13. Excavator according to any of the foregoing claims, wherein the superstructure (11) comprises an articulated arm (13) that is configured to direct the suction hose (3).

14. Excavator according to any of the foregoing claims, wherein the discharge (10) extends from the excavator in a sideward direction.

15. Method of excavating material with an excavator having a suction pump (2), comprising the steps of:

- suctioning excavation material (7) with the suction pump (2);
- receiving and temporarily storing the suctioned excavation material (7) in a container (6); and
- at least partially emptying of the container (6) by discharging excavation material (7) out of the container (6) while the simultaneous step of suctioning excavation material (7) is uninterrupted.

characaterized by the steps of:

- using an excavator according to any of claims 1-14 for displacing excavation material (7) via the outlet guide (15) that is arranged between the outlet (9) and the discharge (10) and that

passes through the radial bearing (12) that rotatably connects the superstructure (11) to the mobile carrier (4).

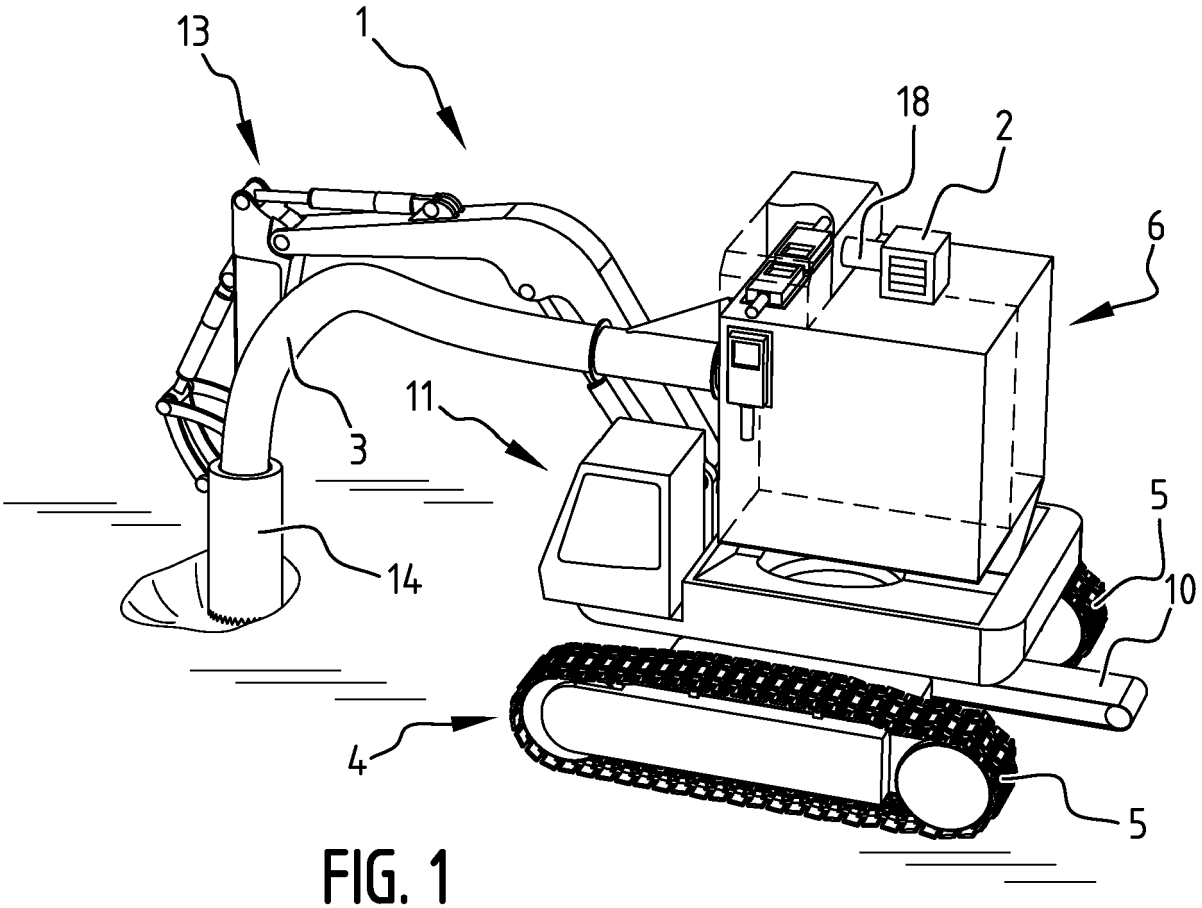

FIG. 1

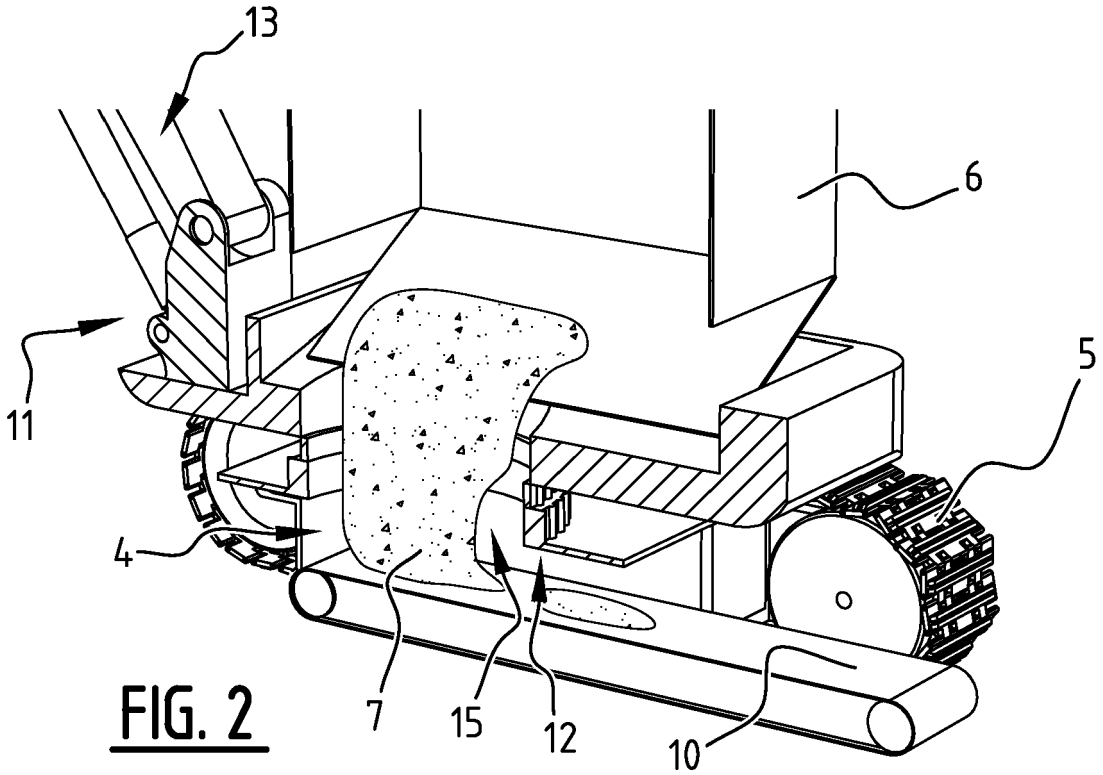

FIG. 2

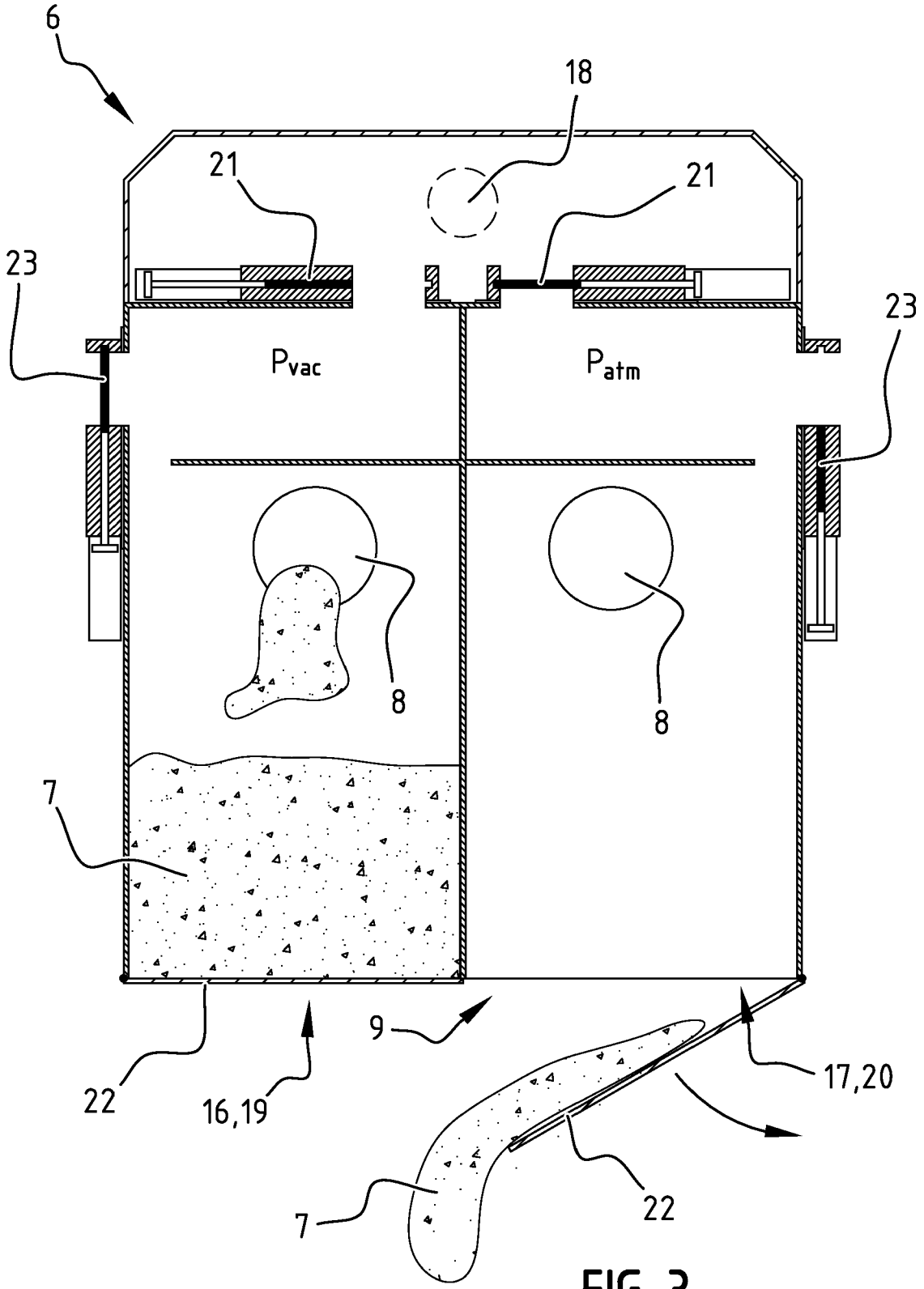

FIG. 3

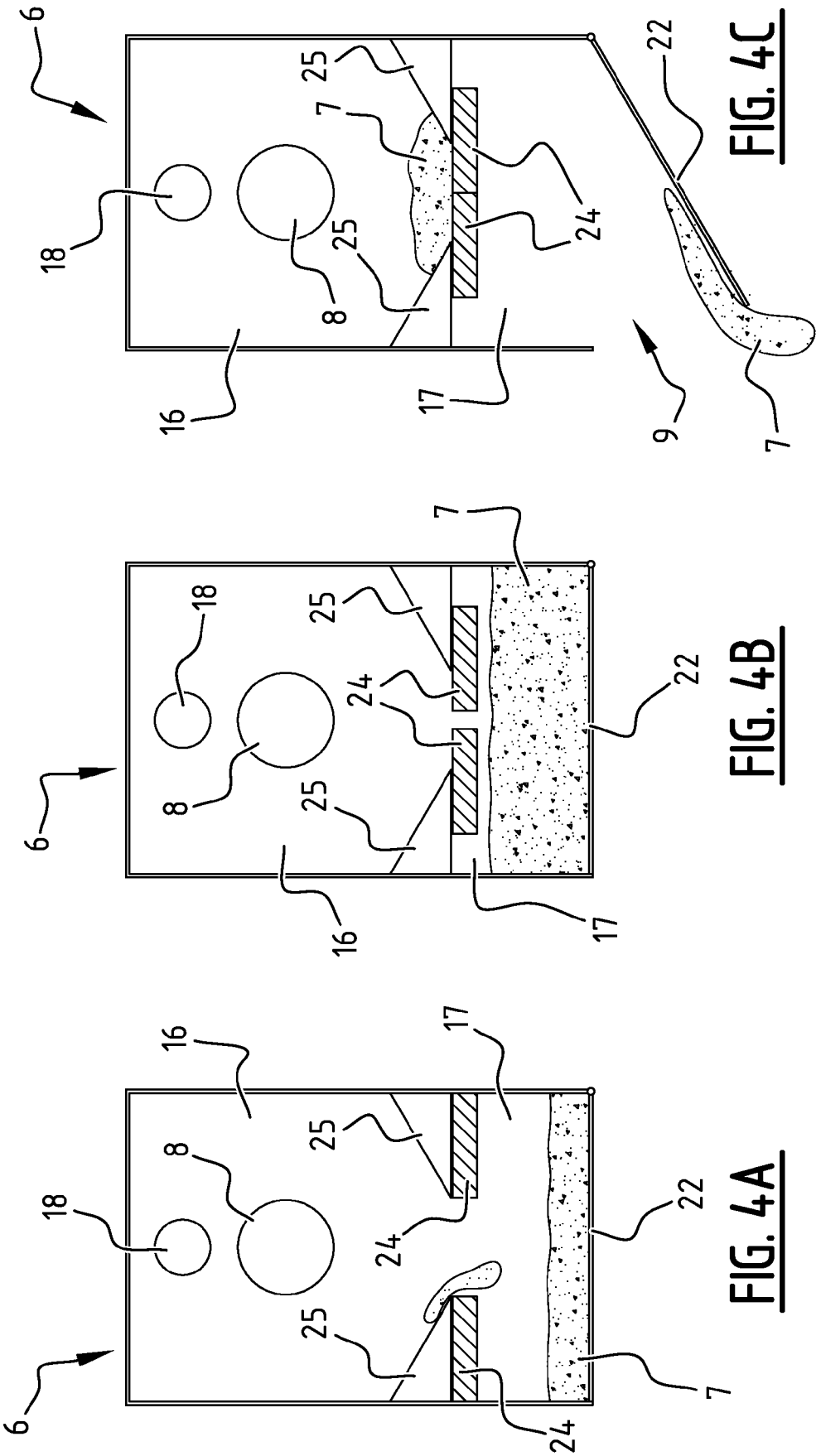

FIG. 4A

FIG. 4B

FIG. 4C

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EUROPEAN SEARCH REPORT

Application Number
EP 20 17 3185

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 October 2020	Bultot, Coralie

CATEGORY OF CITED DOCUMENTS

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